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Occlusion Based Face Recognition

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Abstract—The limited capacity to recognize faces under occlusions is a long-standing problem that presents a unique challenge for face recognition systems and even for humans. The problem regarding occlusion is less covered by research when compared to other challenges such as pose variation, different expressions, etc. Today, the major issues are authentication and identification. Face recognition on Occluded images has many potential applications which have attracted the attention of researchers in the last decade. Nevertheless, occluded face recognition is imperative to exploit the full potential of face recognition for real-world applications. The human face is one of the most popular characteristics which can be used in the biometric security system to identify or verify a user. The face is an acceptable biometric modality because it can be captured from a distance, even without physical contact with the user being identified. Thus the identification or verification does not require the cooperation of the user. Recognition systems based on the human face are used for a wide variety of applications, due to these benefits. However, the crucial task is still to provide reliable recognition accuracy, but it is a challenging problem under real-world conditions.In this paper, we restrict the scope to occluded face recognition. First, we explore what the occlusion problem is and what inherent difficulties can arise. As a part of this review, we introduce face detection under occlusion, a preliminary step in face recognition. Second, we present how existing face recognition methods cope with the occlusion problem.

Keywords—face detection, feature extraction, face recognition, occlusion

I. INTRODUCTION

Face recognition is a computer vision task that has been extensively studied for several years. Compared to other biometrics such as fingerprint recognition, palm recognition and other, face recognition has gained more popularity because of its nature. A facial recognition system analyses the shape and position of different parts of the face to determine a match. Surface features, such as the skin, are also sometimes taken into account.Facial recognition is widely used in domains like forensics, surveillance and border control, etc. Traditional face recognition models have substantially improved the accuracy of the system. However these systems do not achieve comparable recognition rates when encountering challenges such as large-pose variation, varying illumination, low resolution, different facial expressions, and occlusion. Among all the challenges encountered, face occlusion is considered as the most frequent occurring challenge[1][2][4]. Facial occlusion occurs when the subject wears accessories such as a scarf, a face mask, glasses, a hat, etc., or when random objects are present in front of the face. In this paper we aim to solve this problem of recognizing occluded faces and further discussing the scope of the model. The automated system will mainly perform following three steps:

1.Face Detection
2.Feature Extraction
3.Face Recognition

In Face Detection, models use algorithms and Machine learning techniques to find human faces with larger images which often incorporate other non face objects such as hands, buildings, and other background objects. To help ensure accuracy algorithms need to be trained with thousands of positive and negative images. This training improves the accuracy of algorithms to determine whether the human face is present or not.

Feature Extraction is the process of extracting face components features such as eyes, nose, etc. Feature extraction is very much important to further recognize the face. There are various algorithms which rely completely on feature extraction for recognizing the face. We shall further discuss those methods.[13]

Face Recognition is the final step in recognizing the face in which the model compares the face with the already existing images in a dataset.

II. LITERATURE SURVEY

In the paper [1], published by Tanvi B. Patel, Prof. Jalpa T. Patel, Viola Jones algorithm is used and Neural Network is used to recognize faces and give the resultant image by comparing faces from the database.

The paper[2], published by Rohit Tayade, focuses on improving the performance of the CRC method which is a modified version of LRC . In this paper the Viola-Jones algorithm is used for face detection.

The paper[3], published by Yu-A Chen, Wei-Che Chen, Chia-Po Wei, and Yu-Chiang Frank Wang, focuses on restoring the corrupted regions of face images due to extreme lighting variations, occlusion, or even disguise.

In the paper[4], published by Deng-Yuan Huang, Chao-Ho Chen, Tsong-Yi Chen, Jian-He Wu, ChienChuanKo, detection of the face candidate is done using skin color, edges and face area. Then verification of the face candidate is done using the Histogram of Oriented Gradient (HOG) and the two-class classifier C-SVM.

The purpose of the paper[5], published by Ashwin Khadatkar, Roshni Khedgaonkar, K.S.Patnaik, is to improve face recognition accuracy. In this paper the near set theory algorithm is used for face detection, Principal Analysis component (PCA) andSVM is used for occlusion detection and Linear Binary Pattern is used for face recognition.

The Purpose of the paper[6], published by Hua Wang1, Xin Gu1, Xiao Li1, Zhe Li1, Jun Ni2, is to secure ATM normal Transactions. In this paper,the AdaBoost algorithm with cascade classifier is used for occluded face detection.

In the paper[7], published by M.P.Satone, K.K.Wagh, the proposed method is used to detect and recognize the face with high accuracy on color image. They propose Template Matching algorithm for face detection, Skin color model for feature extraction and Principal Analysis Component for face recognition.

In order to Review Face Detection based on Color Image and Binary Image, the authors compare the different color model and method on color image and binary image to detect the face with high accuracy. In the survey[8], conducted by Foram Shah, Chandni Sharma, Shreya Patel, Abhishek More, different color model like RGB, YCbCr,HIS and different face detection methods are used on color models.

III. METHODOLOGY

A. The Viola-Jones Algorithm

The Viola-Jones Algorithm was developed by Viola and Michael Jones in 2001, it is an object feature framework which allows detections of human faces in real-time. Despite being an outdated framework, Viola Jones' algorithm has proven to be powerful and notable in real time face detection. Computer needs precise instructions and constraints to detect a human face, the algorithm requires full view frontal upright faces. To recognize the human face, the computer needs to know which part of the image is to be recognized, thus Viola Jones algorithm makes it easier by detecting the human face which is further matched for recognizing the identity. The algorithm is trained with thousands of positive images and negative images, positive images are images containing human faces and negative images are those without human faces. Given an image for detection the algorithm looks at many smaller subregions and tries to find specific features in each subregion. Algorithm checks many different positions and scales because an image may contain many faces of different sizes. The algorithm uses predefined Haar like features [referring to the figure of edge line feature here] to detect a human face. This algorithm is able to detect the frontal face better than faces looking sideways, upwards and downwards[14]. Viola-Jones Algorithm is mainly divided into 4 sections:

1. Haar Like Features

The haar like features are nothing but digital image features which are used in detecting the human face. There are some universal properties of the human face like the region of eyes is darker than the neighbouring region. There are three types of haar features which are identified by Viola-Jones in their algorithm and they are: [Ref Fig 1.1] [13]

1. Edge feature
2. Line feature
3. Four rectangle feature

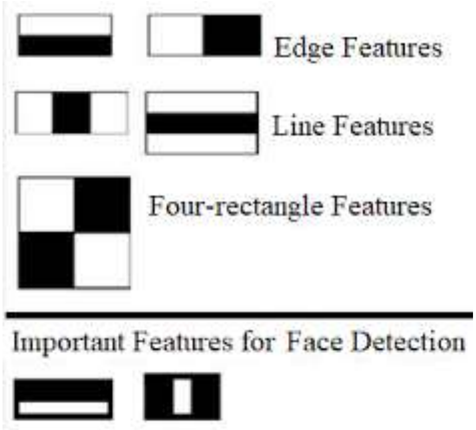


Fig 1.1

Edges and Lines features are used in detecting line features whereas four rectangle features are used in detecting diagonal features. The pixel value is usually computed by subtracting the pixel value of black box from white box(here the black and white boxes are not allocated based on the skin color but rather they are mapped relatively on human faces) [Ref fig 1.1]

2. Creating an integral image.

In this previous section we discussed calculating the pixel value of the image but in reality these calculations can be very intensive and thus to deal with this, integral image plays its part to perform these intensive calculations quickly so that we can understand whether the feature fits the criteria or not. In an integral image, the value of each point is the sum of all pixels above and to the left, including the target pixel:[Ref Fig 1.2]

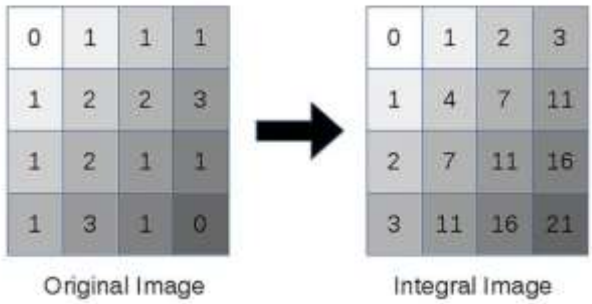


Fig 1.2

3. Running Adaboost training

Next, we use a Machine Learning algorithm known as AdaBoost.

The number of features that are present in the 24×24 detector window is nearly 160,000, but only a few of these features are important to identify a face. So this algorithm uses the AdaBoost algorithm to identify the best features in the 160,000 features. In the Viola-Jones algorithm, each Haar-like feature represents a weak learner. To decide

4. Cascade classification

Maybe the AdaBoost will finally select the best features around say 2500, but it is still a time-consuming process to calculate these features for each region. We have a 24×24 window which we slide over the input image, and we need to find if any of those regions contain the face. The job of the cascade is to quickly discard non-faces, and avoid wasting precious time and computations. Thus, achieving the speed necessary for real-time face detection.

If all classifiers approve the image, it is finally classified as a human face and is presented to the user as a detection.

B. **Local Binary Patterns Histograngram**

Local Binary Pattern (LBP) is a simple yet very efficient texture operation which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number.[7]

Steps in LBPH Algorithm:

1. Parameters:

The LBPH uses 4 parameters:

a. Radius: the radius is used to build the circular local binary pattern and represents the radius around the central pixel. It is usually set to 1.
b. Neighbors: the number of sample points to build the circular local binary pattern. Keep in mind: the more sample points you include, the higher the computational cost. It is usually set to 8.
c. Grid X: the number of cells in the horizontal direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.
d. Grid Y: the number of cells in the vertical direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.

2. Training the Algorithm: First, we need to train the algorithm. To do so, we need to use a dataset with the facial images of the people we want to recognize. We need to also set an ID (it may be a number or the name of the person) for each image, so the algorithm will uses this information to recognize an input image and give us an output. Images of the same person must have the same ID. With the training set already constructed, let's see the LBPH computational steps.[14]

3. Applying the LBP operation: The first computational step of the LBH is to create an intermediate image that describes the original image in a better way, by highlighting the facial characteristics. To do so, the algorithm uses a concept of a sliding window, based on the para meters radius and neighbors.**[Fig 1.3]**

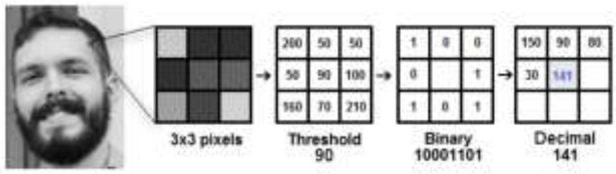


Fig 1.3

4. Extracting the Histograms: Now, using the image generated in the last step, we can use the Grid X and Grid Y parameters to divide the image into multiple grids.

5. Performing the face recognition: In this step, the algorithm is already trained. Each histogram created is used to represent each image from the training dataset. So, given an input image, we perform the steps again for this new image and creates a histogram which represents the image.

So to find the image that matches the input image we just need to compare two histograms and return the image with the closest histogram.

We can use various approaches to compare the histograms (calculate the distance between two histograms), for example: euclidean distance, chi-square, absolute value, etc. In this example, we can use the Euclidean distance (which is quite known) based on the following formula:

$$D = \sqrt{\sum_{i=1}^{n}(hist1_i - hist2_i)^2}$$

So the algorithm output is the ID from the image with the closest histogram. The algorithm should also return the calculated distance, which can be used as a 'confidence' measurement.[5]

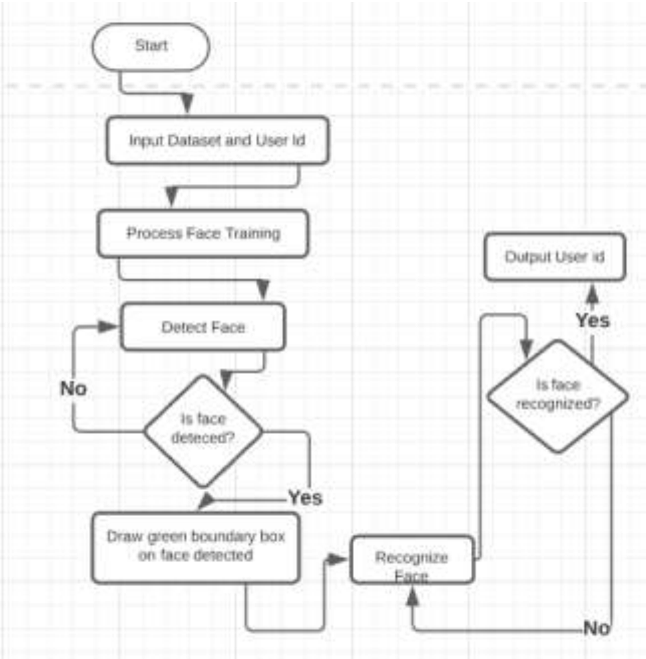
C. **Occlusion**

To handle the occlusion we have modified our model and added the constraint parameter which basically acts as a threshold. While recognizing the face it's obvious that the same person will have less difference (while being occluded) than the different person. Based on the accuracy level our model can determine the surety of face recognition.

IV. DATASET DESCRIPTION

Dataset can be provided to the model by uploading a file or by taking input from a webcam in real-time. While uploading the dataset in real-time we need to first define the number of images to be captured, the more the images stored in the dataset the better is the efficiency of the model, and thus more computing power is required.[12]

V. FLOWCHART



VI. SCOPE

- Medical masks, hard hats, and helmets are required in many restricted environments. Some people also wear veils for religious convictions or cultural habits.
- Our model is inspired by the current need where it is still an obligation in some parts of the world to wear a face mask
- Our model can be used in face recognition attendance systems in Schools, Universities, Banks, etc
- This model can also be used for security purposes such as access control to buildings, airports, seaports, ATM machines, border checkpoints and computer network security.
- In addition, facial occlusions are often related to several severe security issues. Hooligans and criminals,bank robbers and shop thieves usually wear a cap when entering places where they commit illegal actions.
- Thus, it can be used for surveillance i.e. a large number of CCTVs can be monitored to look for known criminals, drug offenders,etc. and authorities can be notified when one is located.
- It also has its application in criminal justice systems like mug-shot, booking systems, post-event analysis, forensics.
- "Smart Card" can also be one application. In lieu of maintaining a database of facial images, the face-print can be stored in a smart card, barcode or magnetic stripe, authentication of which is performed by matching the live image and the stored template.

VII. EXPERIMENTATION AND RESULT

Our model was tested and datasets were uploaded in real-time. Using a webcam we took 30 different images in the predefined intervals and those 30 images were stored in the dataset file. Initially, with the use of the Viola-Jones algorithm we carried out face detection, and once the face was detected a green color box appeared that indicated the boundary of the face and on which face recognition was conducted. Since the face detection model is dynamic in nature, the model is used to detect faces even when an entity is moving. Later using the LBPH algorithm and adding the constrained factor we carried out face recognition and also our model was successful in recognizing the faces which were occluded with face masks, sunglasses, and hats. Accuracy on our system mainly depends upon the algorithms which we have used and mentioned in this paper and also factors such as intensity of light where the face recognition needs to be carried out and also depends upon the movement of the entity and how much face is being occluded.

Sample Output: Ref Fig 1.4

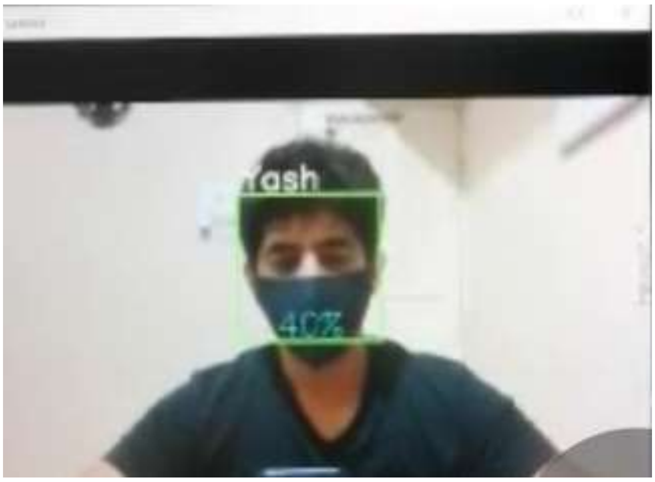


Fig 1.4

VIII. CONCLUSION

In this paper, we present a thorough survey of face recognition techniques and how some of the techniques could be used while recognizing the face with occlusion. We discussed what are the steps involved in face recognition and further discussed each of those steps. Later we discussed what algorithms we have used in conducting the face recognition and studied those algorithms in detail. In the end, we discuss future challenges in terms of dataset and research (including potential solutions) that move the field forward.

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